

**TITLE: METHOD OF INFERRING ROTORCRAFT GROSS WEIGHT**

Inventors: Timothy D. Flynn, et al.

Filed: February 13, 2004

BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 1 of 33

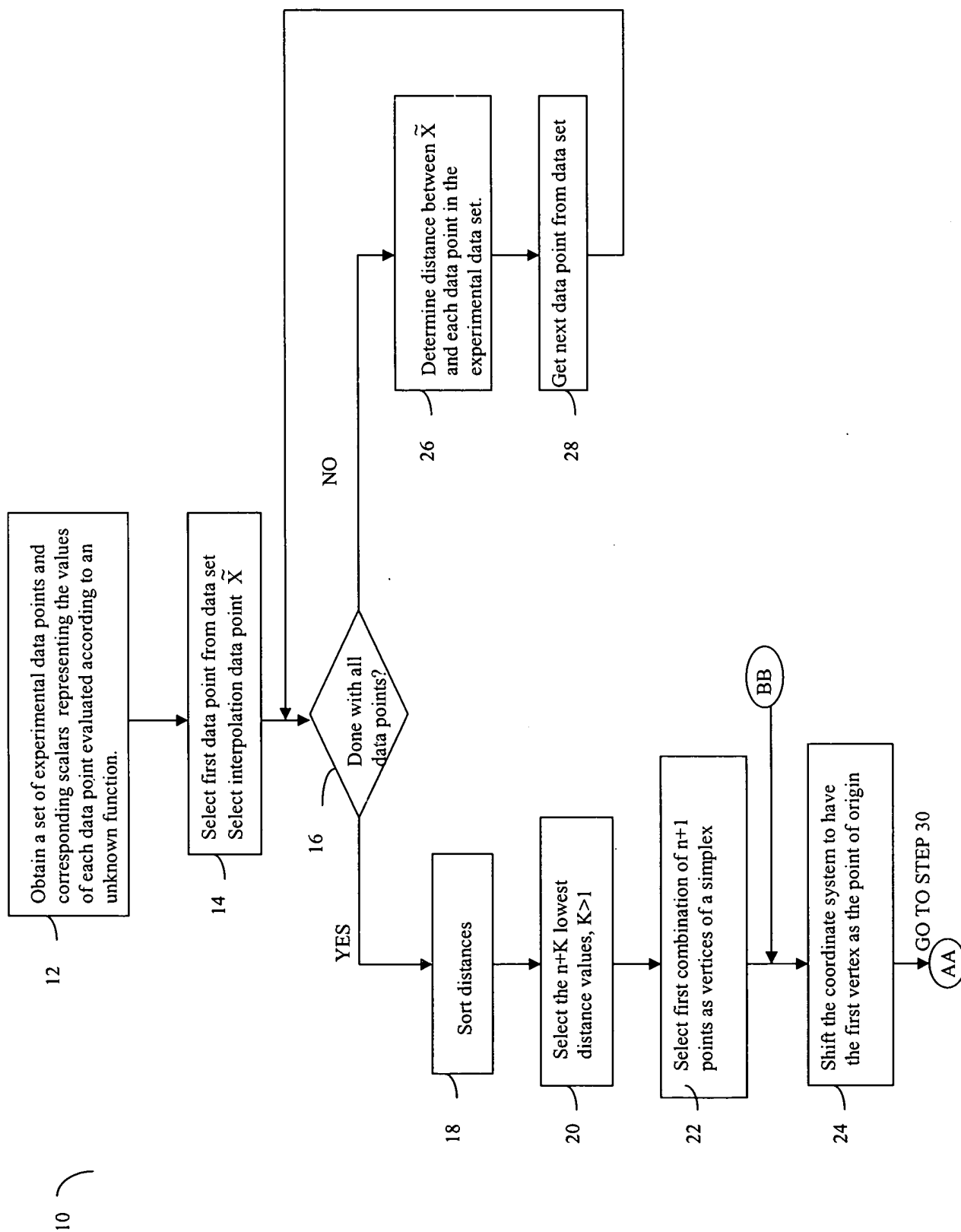


FIGURE 1

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Reg. No.: 41,290

Sheet 2 of 33

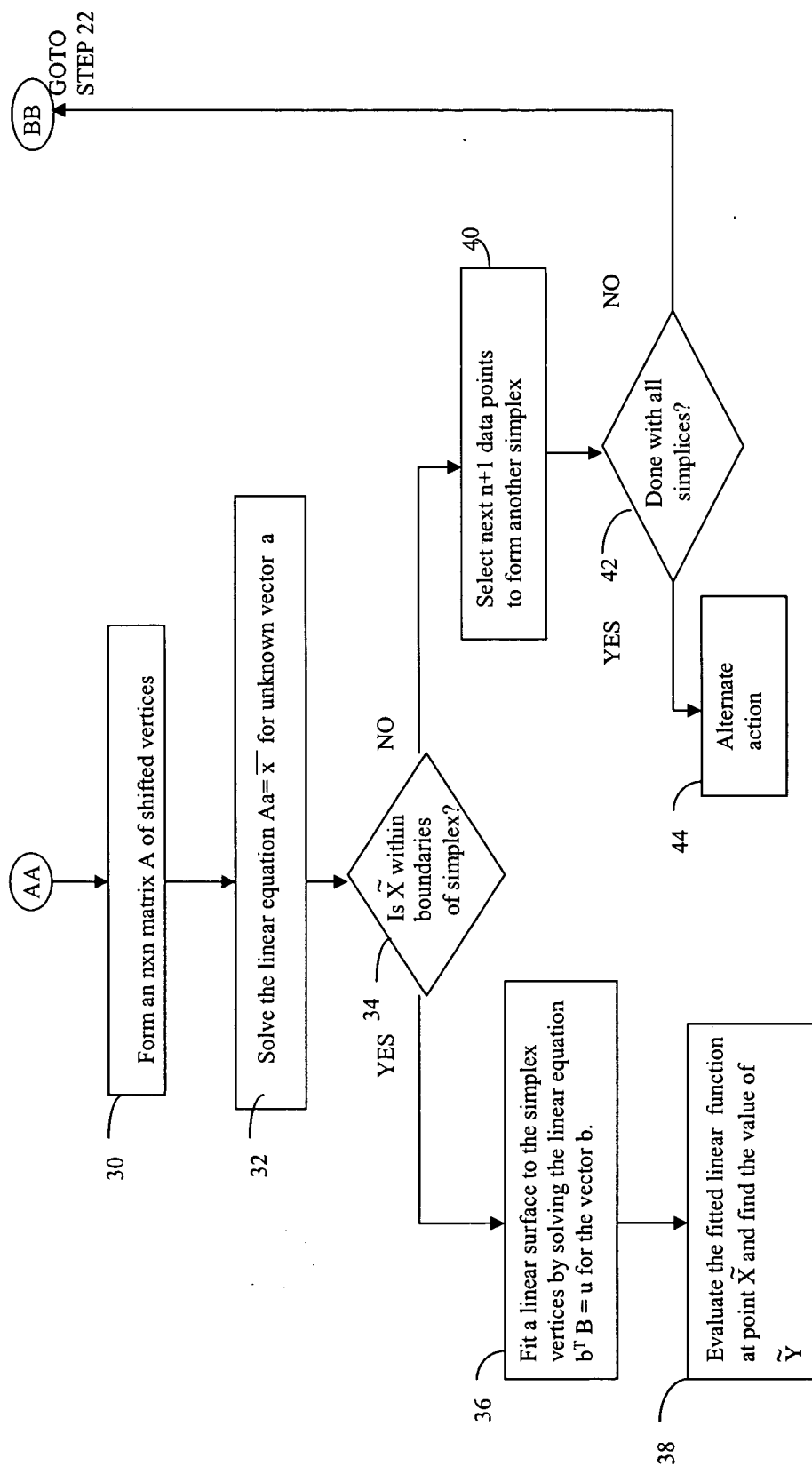


FIGURE 2

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BFM-02501

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Reg. No.: 41,290

Sheet 3 of 33

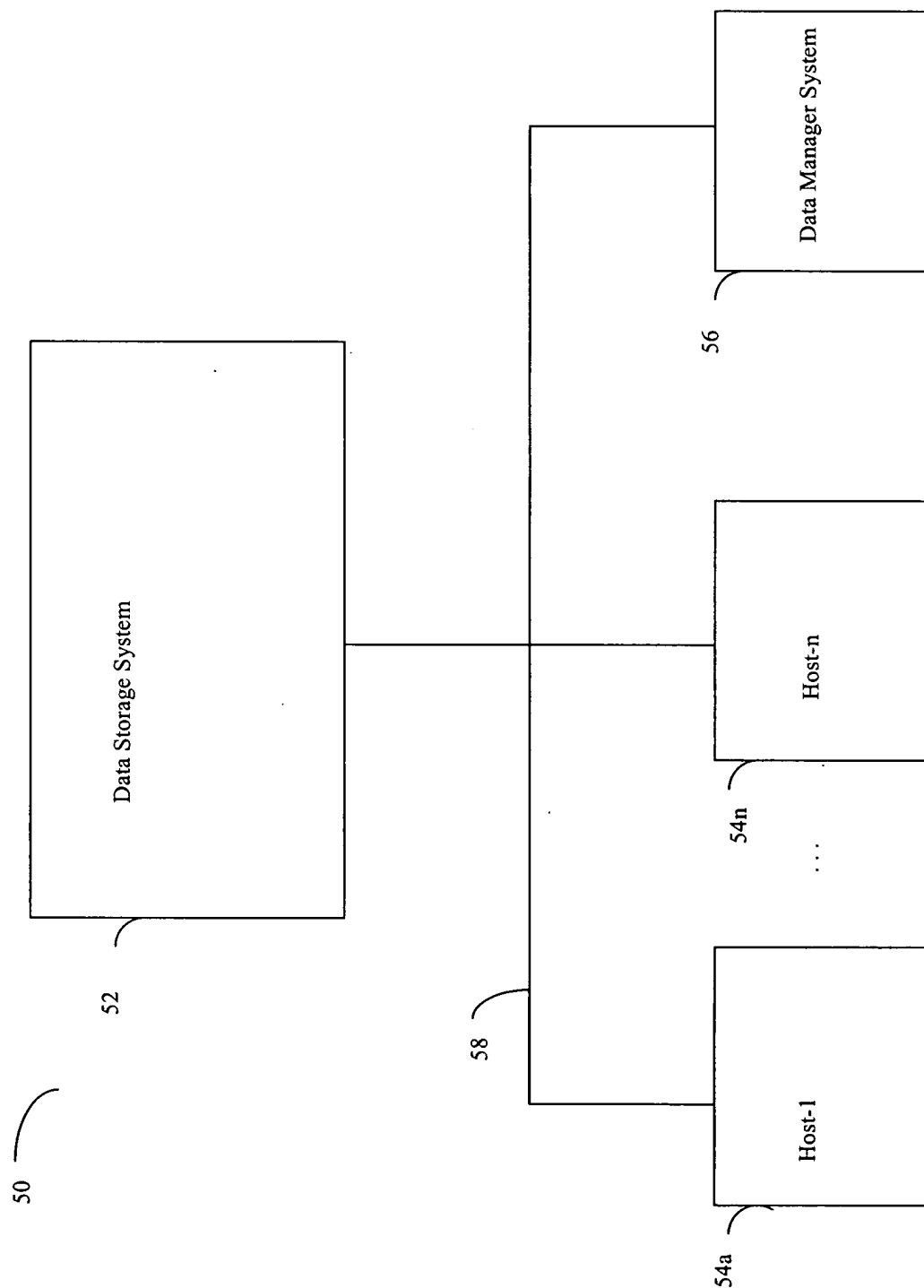


FIGURE 3

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BFM-02501

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Reg. No.: 41,290

Sheet 4 of 33

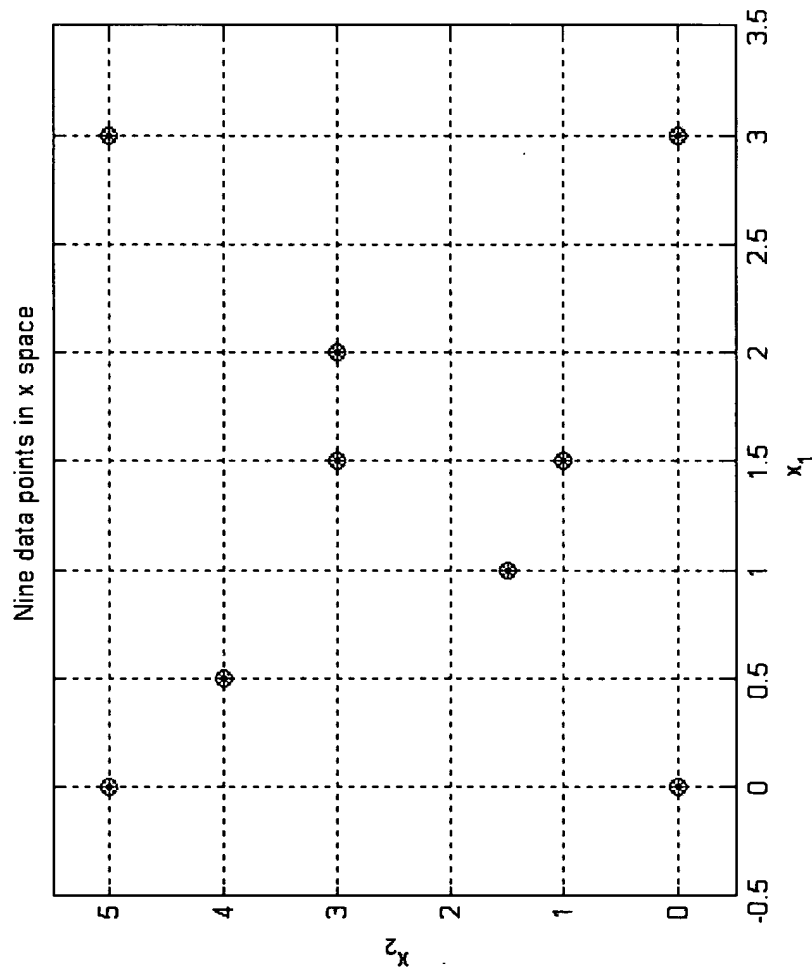


FIGURE 4

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Reg. No.: 41,290

Sheet 5 of 33

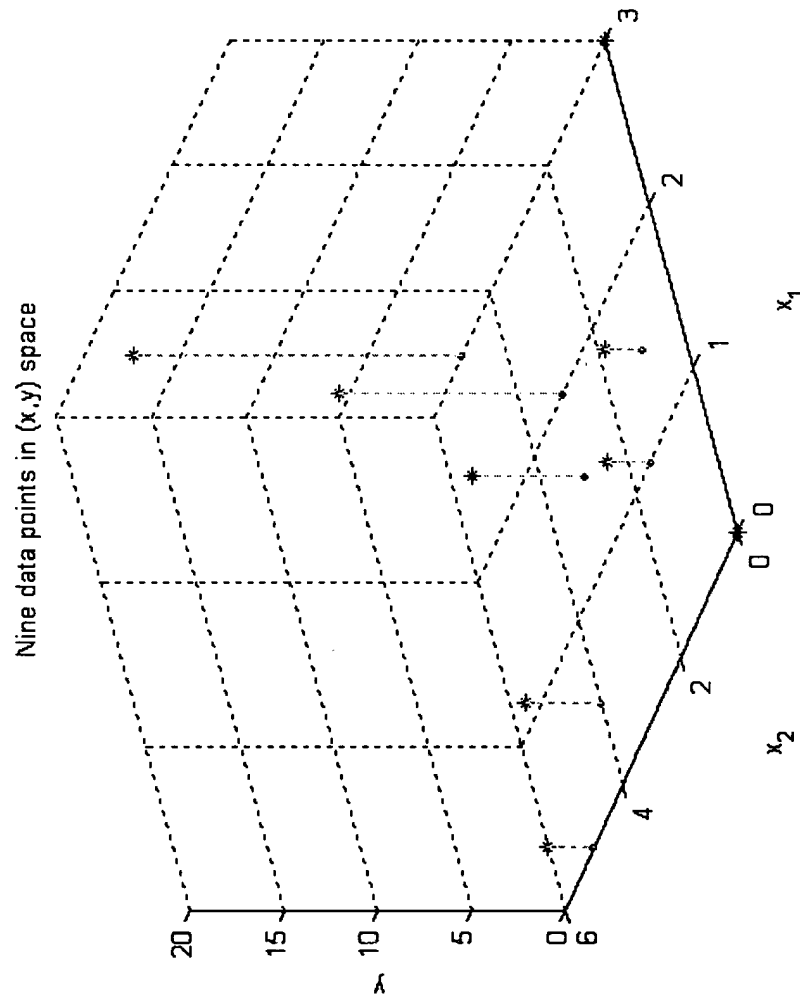


FIGURE 5

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BFM-02501

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Reg. No.: 41,290

Sheet 6 of 33

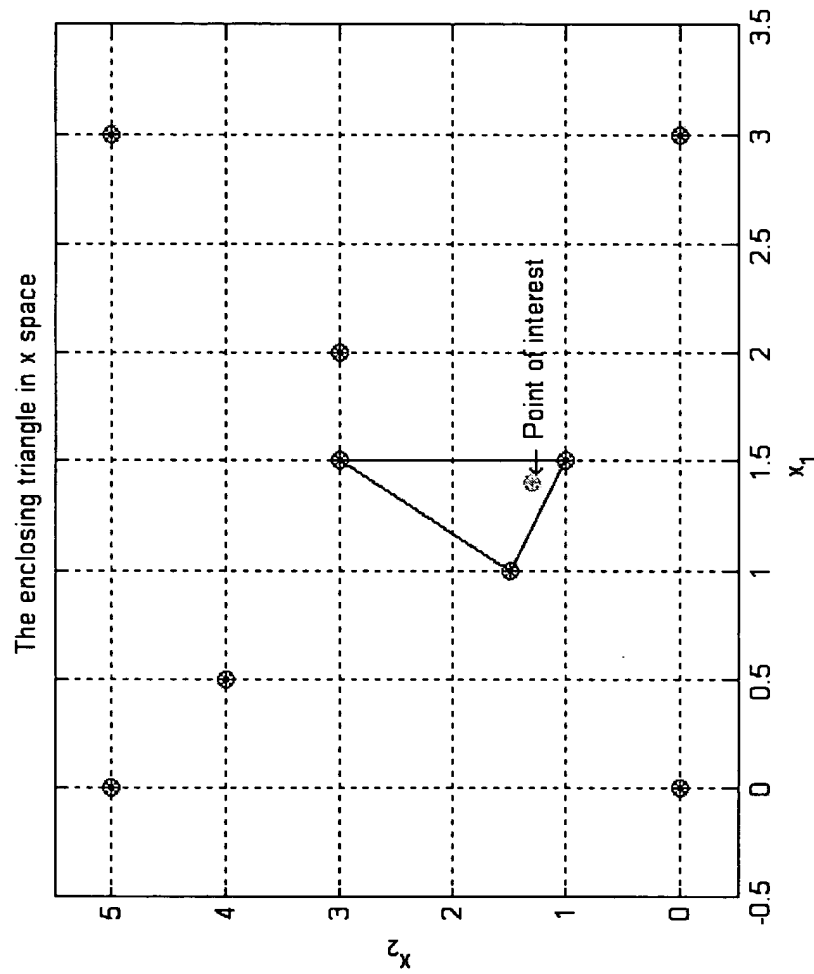


FIGURE 6

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BFM-02501

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Reg. No.: 41,290

Sheet 7 of 33

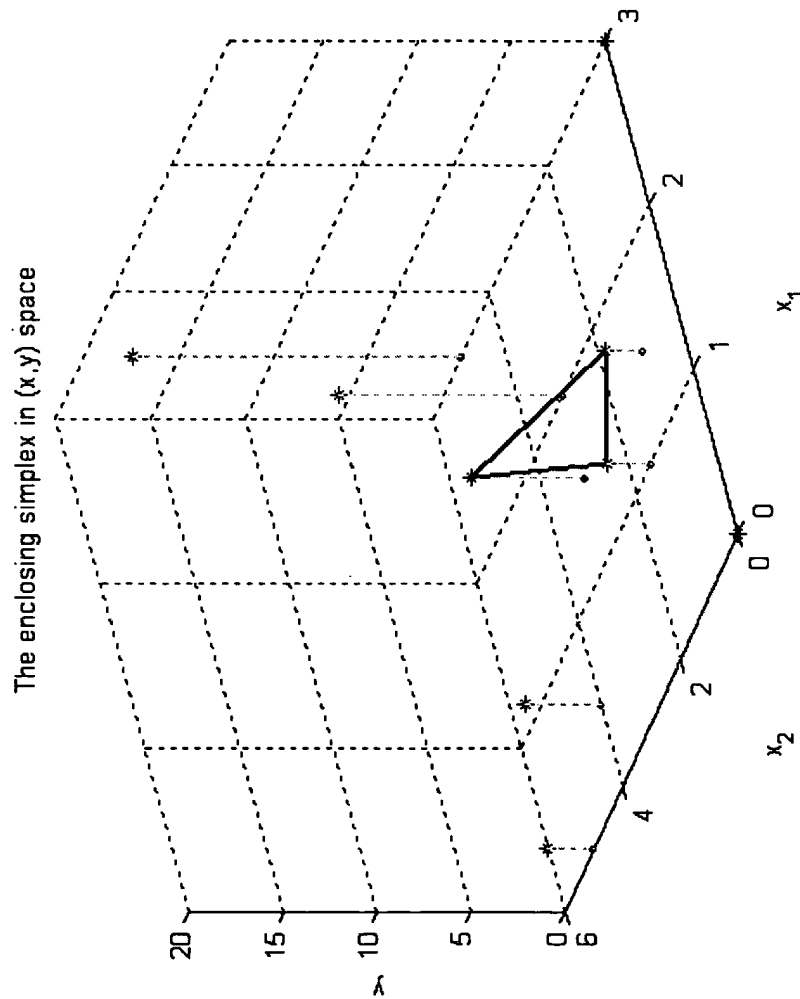


FIGURE 7

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BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 8 of 33

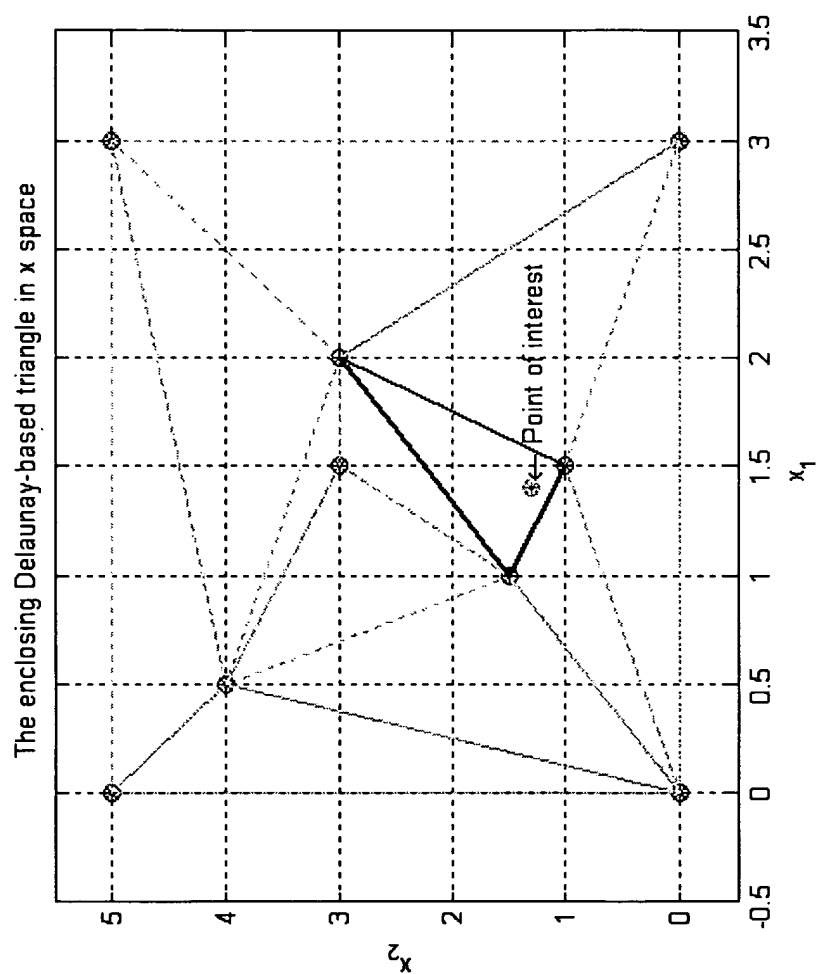


FIGURE 8



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BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 9 of 33

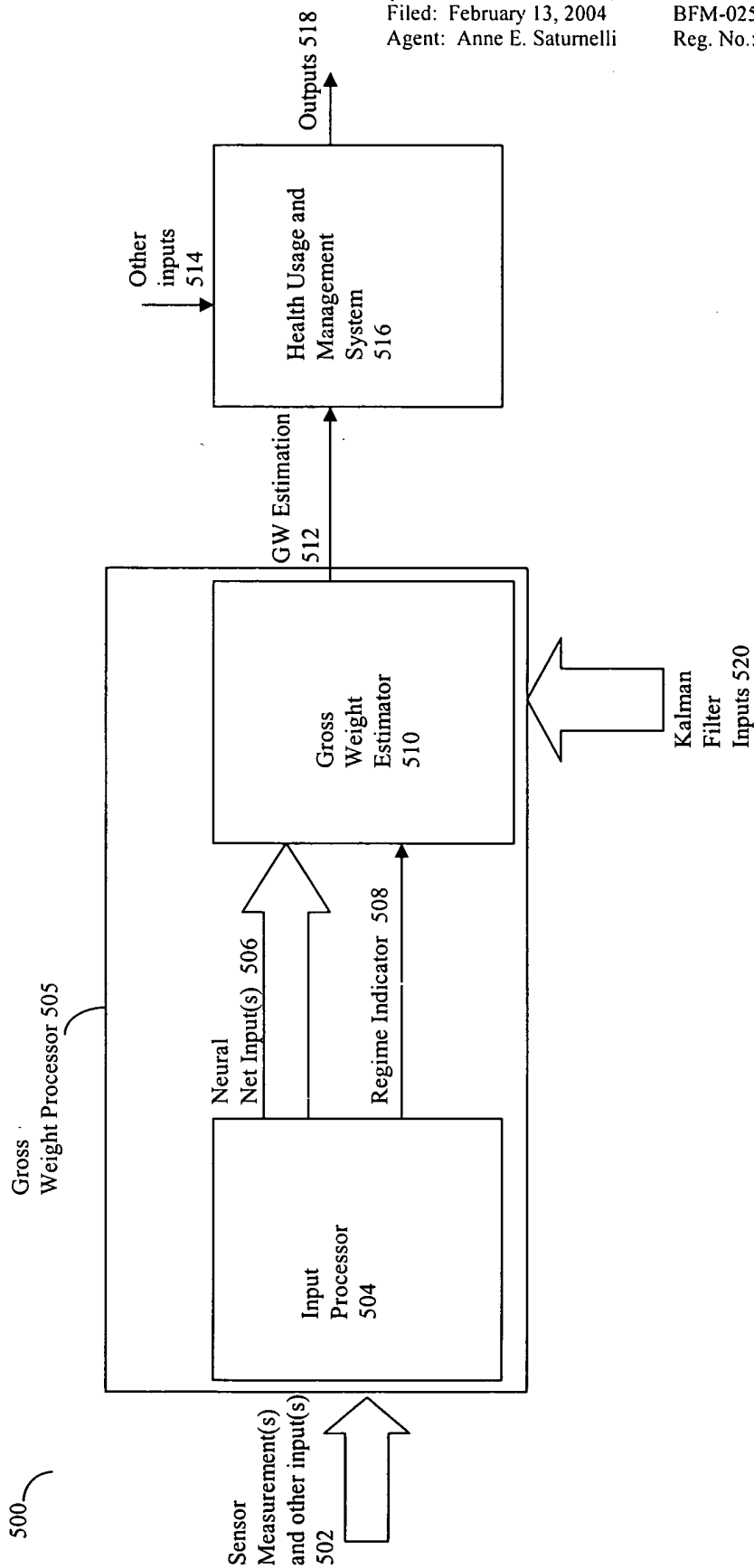


FIGURE 9

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Filed: February 13, 2004 BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 10 of 33

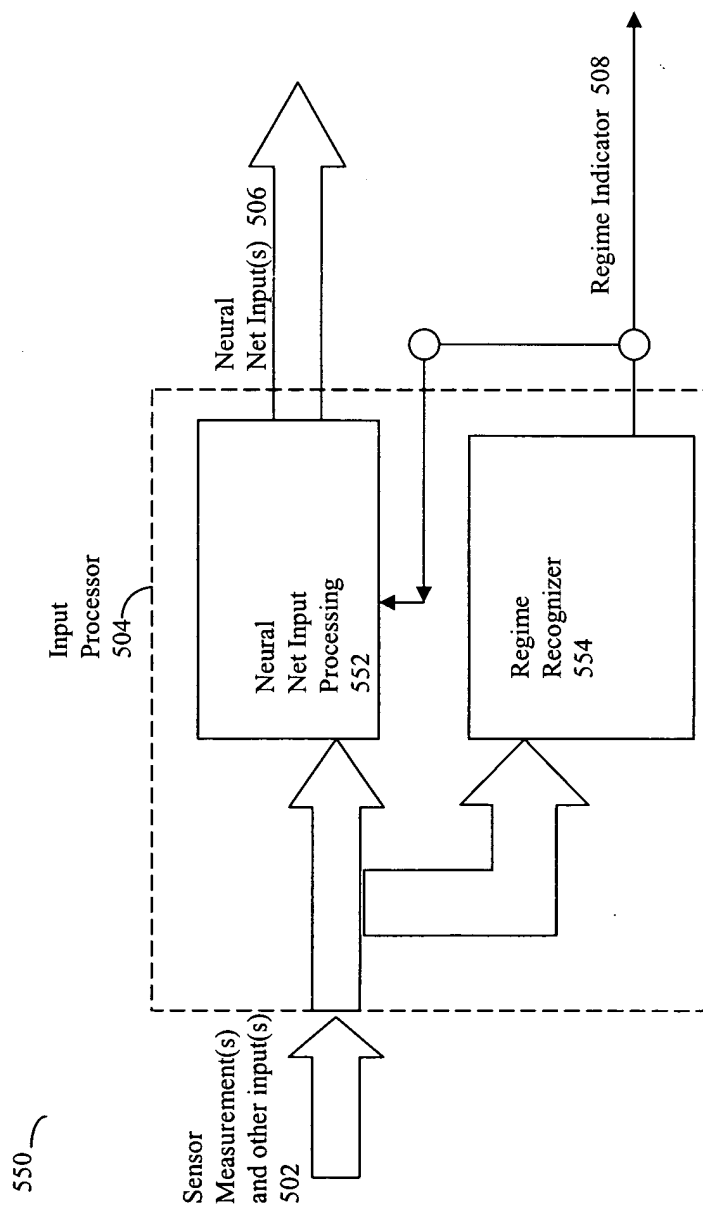


FIGURE 10

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BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 11 of 33

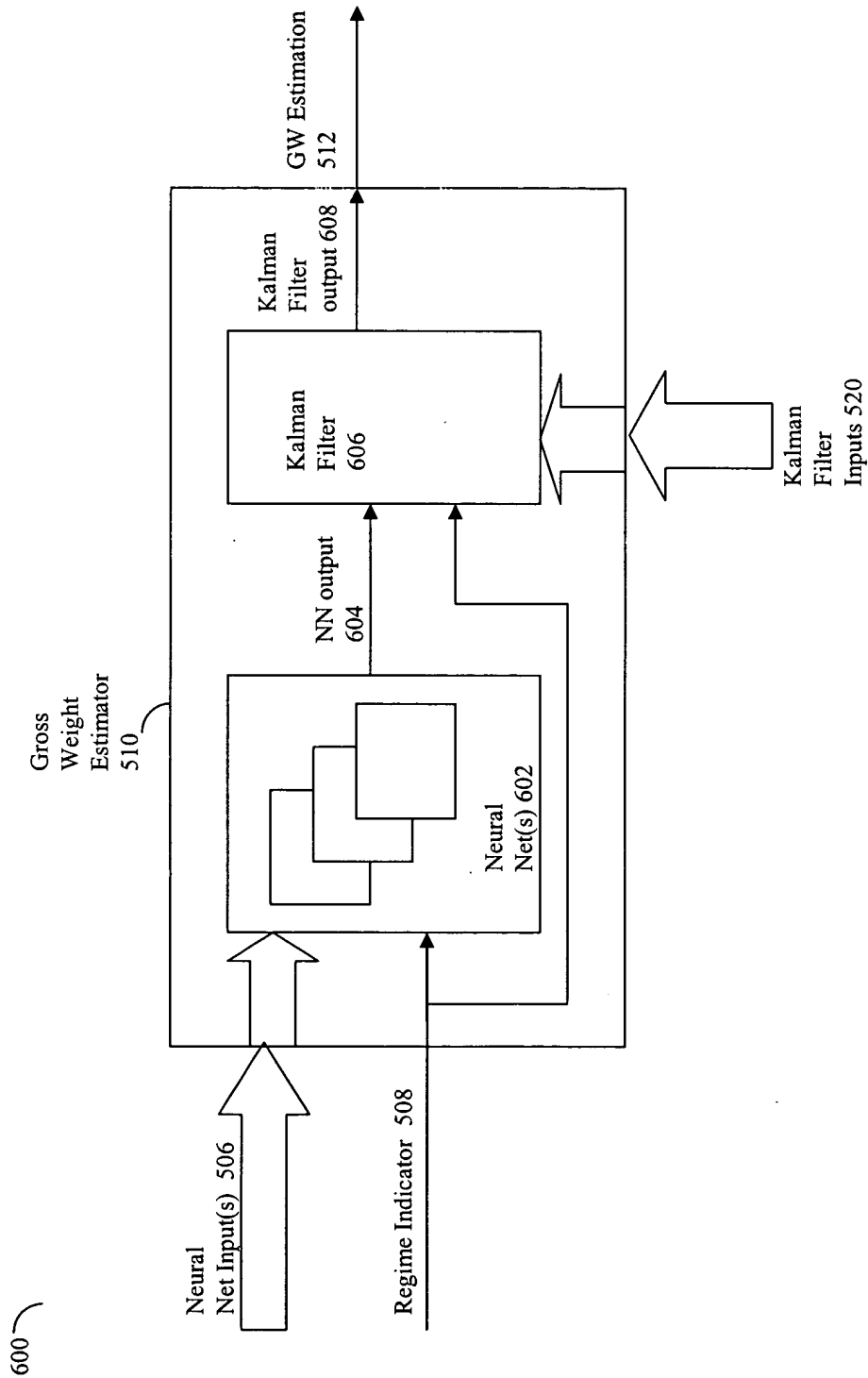


FIGURE 11

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Reg. No.: 41,290

Sheet 12 of 33

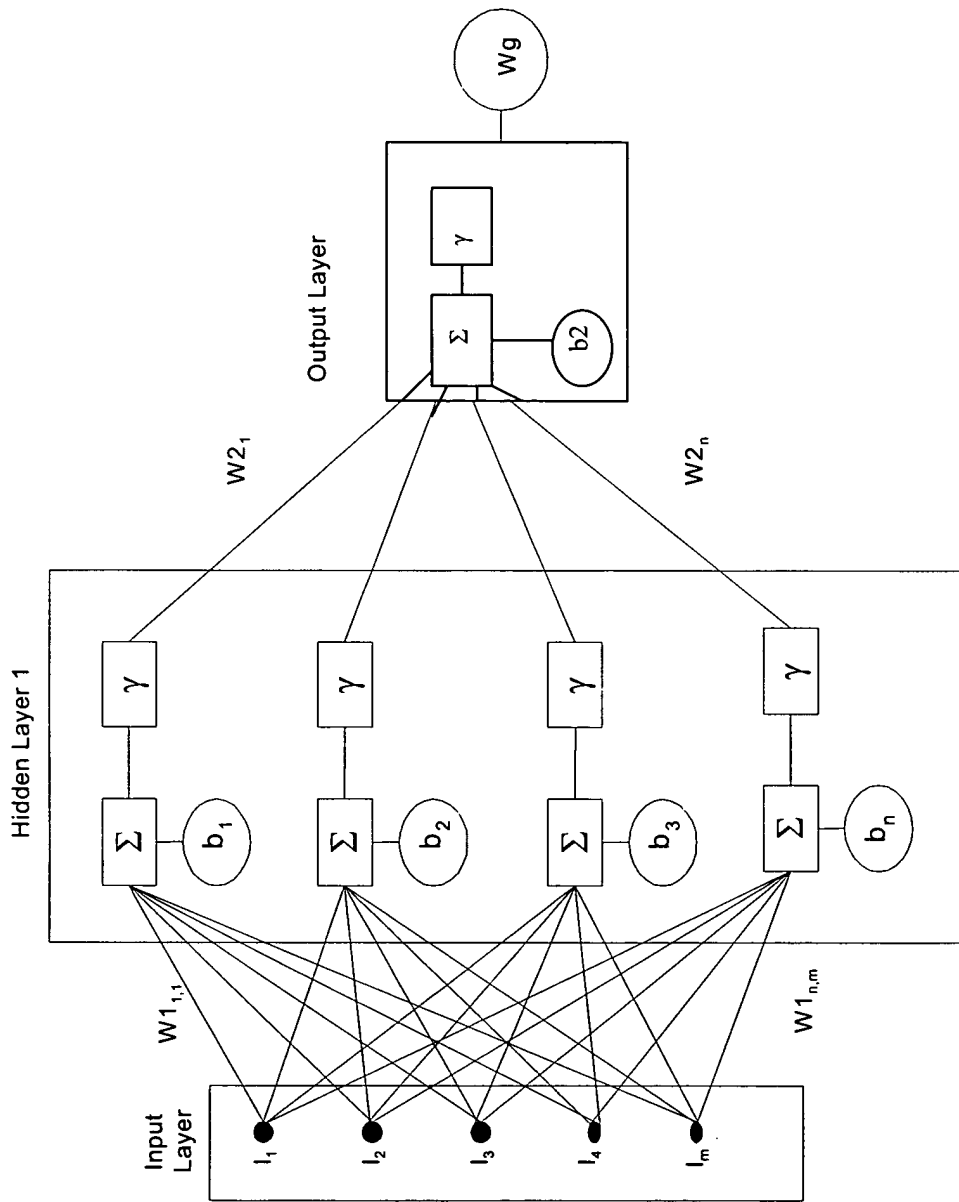


FIGURE 12

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Agent: Anne E. Saturnelli Reg. No.: 41,290

Sheet 13 of 33

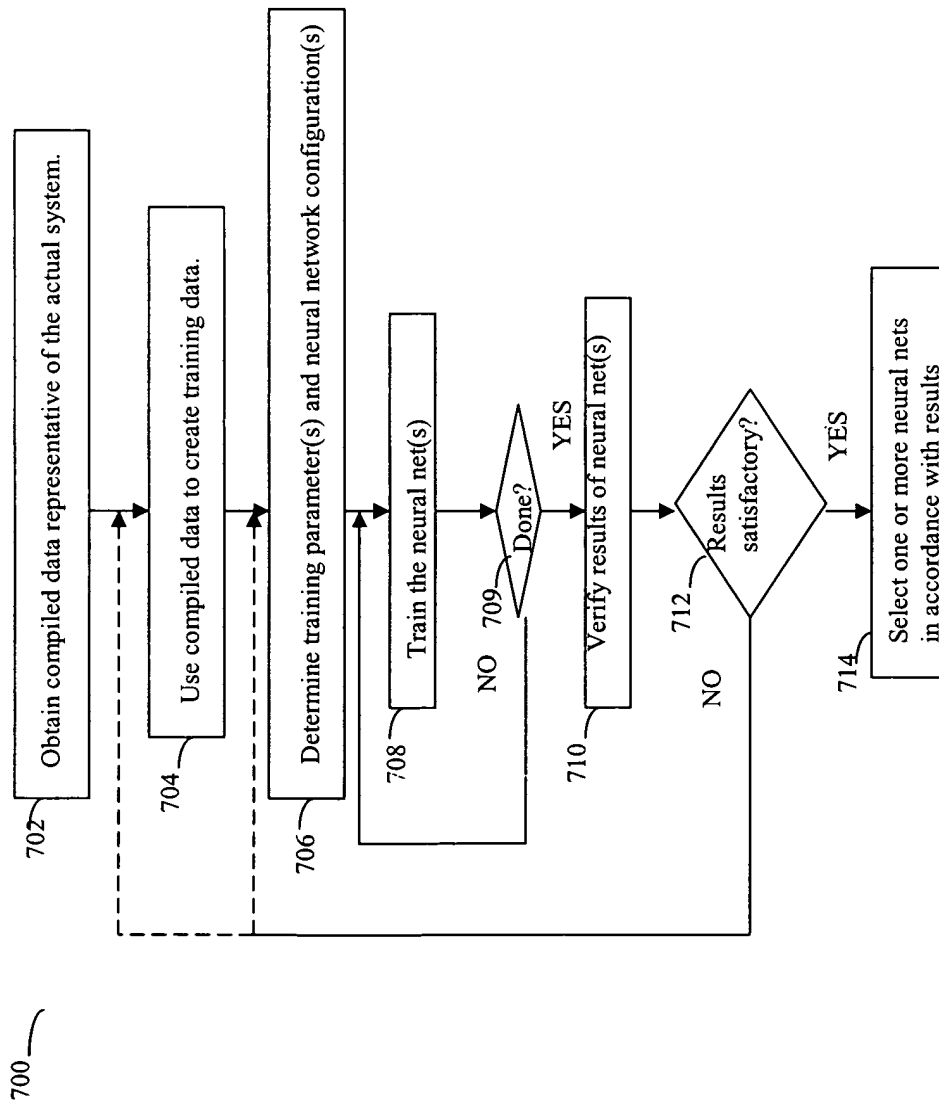


FIGURE 13

## Regime— Steady State Hover

| Maneuver Name         | Hover        |           |            |
|-----------------------|--------------|-----------|------------|
| Category              | Steady State |           |            |
| Type                  | Specific     |           |            |
| Parameter             | Operator     | Threshold | Hysteresis |
| Landing Flag          | =            | False     | None       |
| Takeoff Flag          | =            | False     | None       |
| WOW                   | =            | False     | None       |
| Yaw Rate              | <=           | 2.5       | None       |
| Yaw Rate              | >=           | -2.5      | None       |
| Rate of Climb         | >=           | -200      | None       |
| Rate of Climb         | <=           | 200       | None       |
| Pitch Attitude        | <            | 10        | None       |
| Roll Attitude         | <=           | 3         | None       |
| Roll Attitude         | >=           | -6        | None       |
| Drift Velocity        | >=           | -7        | None       |
| Drift Velocity        | <=           | 7         | None       |
| Ground Speed          | >=           | -7        | None       |
| Ground Speed          | <=           | 7         | None       |
| Calibrated Airspeed   | <=           | 38        | 5          |
| Control Reversal Flag | =            | 0         | None       |

FIGURE 14

# Regime— Steady State Forward Flight

| Maneuver Name         | Forward Flight |           |            |  |
|-----------------------|----------------|-----------|------------|--|
| Category              | Steady State   |           |            |  |
| Type                  | Specific       |           |            |  |
| Parameter             | Operator       | Threshold | Hysteresis |  |
| Landing Flag          | =              | False     | None       |  |
| Takeoff Flag          | =              | False     | None       |  |
| WOW                   | =              | False     | None       |  |
| Roll Attitude         | >=             | -10       | None       |  |
| Roll Attitude         | <=             | 10        | None       |  |
| Rate of Climb         | >=             | -500      | None       |  |
| Rate of Climb         | <=             | 500       | None       |  |
| Sideslip              | <=             | .05       | None       |  |
| Sideslip              | >=             | -.05      | None       |  |
| Pitch Attitude        | <=             | 10        | None       |  |
| Pitch Attitude        | >=             | -10       | None       |  |
| Yaw Rate              | >=             | -5        | None       |  |
| Yaw Rate              | <=             | 5         | None       |  |
| Calibrated Airspeed   | >              | 38        | 5          |  |
| Control Reversal Flag | =              | 0         | None       |  |

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BFM-02501

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Reg. No.: 41,290

Sheet 15 of 33

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Filed: February 13, 2004

BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 16 of 33

## Regime - Turn

| Maneuver Name       | Turn      |           |            |
|---------------------|-----------|-----------|------------|
| Category            | Transient |           |            |
| Parameter           | Operator  | Threshold | Hysteresis |
| Landing Flag        | =         | False     | None       |
| Takeoff Flag        | =         | False     | None       |
| WOW                 | =         | False     | None       |
| Roll Attitude       | <         | -10       | 3          |
| *Roll Attitude      | >         | 10        | 3          |
| Rate of Climb       | >=        | -500      | None       |
| Rate of Climb       | <=        | 500       | None       |
| Calibrated Airspeed | >         | 38        | 2          |

FIGURE 16



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BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 17 of 33

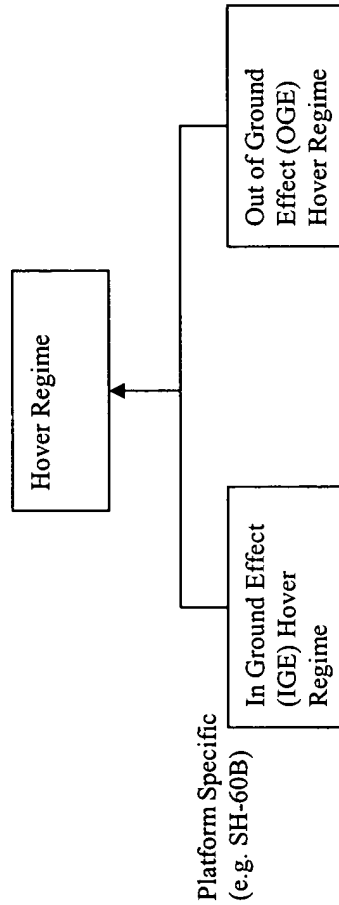


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BFM-02501

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Reg. No.: 41,290

Sheet 18 of 33

**Regime 1 - Level Flight, up to  $0.2 V_H$**

Description: Straight and level flight at close to 1.0 G conditions, airspeed less than  $0.2 V_H$ .

| Maneuver Name         | Level Flight, $0.2 V_H$ |           |            |  |
|-----------------------|-------------------------|-----------|------------|--|
| Category              | Steady State            |           |            |  |
| Type                  | Specific                |           |            |  |
| Parameter             | Operator                | Threshold | Hysteresis |  |
| Landing Flag          | =                       | False     | None       |  |
| Takeoff Flag          | =                       | False     | None       |  |
| WOW                   | =                       | False     | None       |  |
| Roll Attitude         | >=                      | -10       | None       |  |
| Roll Attitude         | <=                      | 10        | None       |  |
| Rate of Climb         | >=                      | -500      | None       |  |
| Rate of Climb         | <=                      | 500       | None       |  |
| Sideslip              | <=                      | .05       | None       |  |
| Sideslip              | >=                      | -.05      | None       |  |
| Pitch Attitude        | <=                      | 10        | None       |  |
| Pitch Attitude        | >=                      | -10       | None       |  |
| Yaw Rate              | >=                      | -5        | None       |  |
| Yaw Rate              | <=                      | 5         | None       |  |
| VH Fraction           | <=                      | 0.2       | 0.01       |  |
| Corrected Load Factor | >=                      | 0.85      | None       |  |
| Corrected Load Factor | <=                      | 1.18      | None       |  |
| Calibrated Airspeed   | >                       | 38        | 5          |  |
| Control Reversal Flag | =                       | 0         | None       |  |

FIGURE 18

## Regime 2 - Level Flight, $0.4 V_H$

Description: Straight and level flight at close to 1.0 G conditions, airspeed from  $0.2 V_H$  to  $0.4 V_H$ .

| Maneuver Name         | Level Flight, $0.4 V_H$ |           |            |
|-----------------------|-------------------------|-----------|------------|
| Category              | Steady State            |           |            |
| Type                  | Specific                |           |            |
| Parameter             | Operator                | Threshold | Hysteresis |
| Landing Flag          | =                       | False     | None       |
| Takeoff Flag          | =                       | False     | None       |
| WOW                   | =                       | False     | None       |
| Roll Attitude         | >=                      | -10       | None       |
| Roll Attitude         | <=                      | 10        | None       |
| Rate of Climb         | >=                      | -500      | None       |
| Rate of Climb         | <=                      | 500       | None       |
| Sideslip              | <=                      | .05       | None       |
| Sideslip              | >=                      | -.05      | None       |
| Pitch Attitude        | <=                      | 10        | None       |
| Pitch Attitude        | >=                      | -10       | None       |
| Yaw Rate              | >=                      | -5        | None       |
| Yaw Rate              | <=                      | 5         | None       |
| VH Fraction           | >                       | 0.2       | 0.01       |
| VH Fraction           | <=                      | 0.4       | 0.01       |
| Corrected Load Factor | >=                      | 0.85      | None       |
| Corrected Load Factor | <=                      | 1.18      | None       |
| Calibrated Airspeed   | >                       | 38        | 5          |
| Control Reversal Flag | =                       | 0         | None       |

FIGURE 19

### Regime 3 - Level Flight, $0.5 V_H$

Description: Straight and level flight at close to 1.0 G conditions, airspeed from  $0.4 V_H$  to  $0.5 V_H$ .

| Maneuver Name         | Level Flight, $0.5 V_H$ |           |            |  |
|-----------------------|-------------------------|-----------|------------|--|
| Category              | Steady State            |           |            |  |
| Type                  | Specific                |           |            |  |
| Parameter             | Operator                | Threshold | Hysteresis |  |
| Landing Flag          | =                       | False     | None       |  |
| Takeoff Flag          | =                       | False     | None       |  |
| WOW                   | =                       | False     | None       |  |
| Roll Attitude         | >=                      | -10       | None       |  |
| Roll Attitude         | <=                      | 10        | None       |  |
| Rate of Climb         | >=                      | -500      | None       |  |
| Rate of Climb         | <=                      | 500       | None       |  |
| Sideslip              | <=                      | .05       | None       |  |
| Sideslip              | >=                      | -.05      | None       |  |
| Pitch Attitude        | <=                      | 10        | None       |  |
| Pitch Attitude        | >=                      | -10       | None       |  |
| Yaw Rate              | >=                      | -5        | None       |  |
| Yaw Rate              | <=                      | 5         | None       |  |
| VH Fraction           | >                       | 0.4       | 0.01       |  |
| VH Fraction           | <=                      | 0.5       | 0.01       |  |
| Corrected Load Factor | >=                      | 0.85      | None       |  |
| Corrected Load Factor | <=                      | 1.18      | None       |  |
| Calibrated Airspeed   | >                       | 38        | 5          |  |
| Control Reversal Flag | =                       | 0         | None       |  |

FIGURE 20

## Regime 4 - Level Flight, 0.6 $V_H$

Description: Straight and level flight at close to 1.0 G conditions, airspeed from 0.5  $V_H$  to 0.6  $V_H$ .

| Maneuver Name         | Level Flight, 0.6 $V_H$ |           |            |
|-----------------------|-------------------------|-----------|------------|
| Category              | Steady State            |           |            |
| Type                  | Specific                |           |            |
| Parameter             | Operator                | Threshold | Hysteresis |
| Landing Flag          | =                       | False     | None       |
| Takeoff Flag          | =                       | False     | None       |
| WOW                   | =                       | False     | None       |
| Roll Attitude         | >=                      | -10       | None       |
| Roll Attitude         | <=                      | 10        | None       |
| Rate of Climb         | >=                      | -500      | None       |
| Rate of Climb         | <=                      | 500       | None       |
| Sideslip              | <=                      | .05       | None       |
| Sideslip              | >=                      | -.05      | None       |
| Pitch Attitude        | <=                      | 10        | None       |
| Pitch Attitude        | >=                      | -10       | None       |
| Yaw Rate              | >=                      | -5        | None       |
| Yaw Rate              | <=                      | 5         | None       |
| VH Fraction           | >                       | 0.5       | 0.01       |
| VH Fraction           | <=                      | 0.6       | 0.01       |
| Corrected Load Factor | >=                      | 0.85      | None       |
| Corrected Load Factor | <=                      | 1.18      | None       |
| Calibrated Airspeed   | >                       | 38        | 5          |
| Control Reversal Flag | =                       | 0         | None       |

FIGURE 21

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Filed: February 13, 2004 BFM-02501

Agent: Anne E. Saturnelli Reg. No.: 41,290

Sheet 21 of 33

## Regime 5 - Level Flight, $0.7 V_H$

Description: Straight and level flight at close to 1.0 G conditions, airspeed from  $0.6 V_H$  to  $0.7 V_H$ .

| Maneuver Name         | Level Flight, $0.7 V_H$ |           |            |  |
|-----------------------|-------------------------|-----------|------------|--|
| Category              | Steady State            |           |            |  |
| Type                  | Specific                |           |            |  |
| Parameter             | Operator                | Threshold | Hysteresis |  |
| Landing Flag          | =                       | False     | None       |  |
| Takeoff Flag          | =                       | False     | None       |  |
| WOW                   | =                       | False     | None       |  |
| Roll Attitude         | >=                      | -10       | None       |  |
| Roll Attitude         | <=                      | 10        | None       |  |
| Rate of Climb         | >=                      | -500      | None       |  |
| Rate of Climb         | <=                      | 500       | None       |  |
| Sideslip              | <=                      | .05       | None       |  |
| Sideslip              | >=                      | -.05      | None       |  |
| Pitch Attitude        | <=                      | 10        | None       |  |
| Pitch Attitude        | >=                      | -10       | None       |  |
| Yaw Rate              | >=                      | -5        | None       |  |
| Yaw Rate              | <=                      | 5         | None       |  |
| VH Fraction           | >                       | 0.6       | 0.01       |  |
| VH Fraction           | <=                      | 0.7       | 0.01       |  |
| Corrected Load Factor | >=                      | 0.85      | None       |  |
| Corrected Load Factor | <=                      | 1.18      | None       |  |
| Calibrated Airspeed   | >                       | 38        | 5          |  |
| Control Reversal Flag | =                       | 0         | None       |  |

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Filed: February 13, 2004

Agent: Anne E. Saturnelli

BFM-02501

Reg. No.: 41,290

Sheet 22 of 33

## Regime 6 - Level Flight, 0.8 $V_H$

Description: Straight and level flight at close to 1.0 G conditions, airspeed from 0.7  $V_H$  to 0.8  $V_H$ .

| Maneuver Name         | Level Flight, 0.8 $V_H$ |           |            |
|-----------------------|-------------------------|-----------|------------|
| Category              | Steady State            |           |            |
| Type                  | Specific                |           |            |
| Parameter             | Operator                | Threshold | Hysteresis |
| Landing Flag          | =                       | False     | None       |
| Takeoff Flag          | =                       | False     | None       |
| WOW                   | =                       | False     | None       |
| Roll Attitude         | >=                      | -10       | None       |
| Roll Attitude         | <=                      | 10        | None       |
| Rate of Climb         | >=                      | -500      | None       |
| Rate of Climb         | <=                      | 500       | None       |
| Sideslip              | <=                      | .05       | None       |
| Sideslip              | >=                      | -.05      | None       |
| Pitch Attitude        | <=                      | 10        | None       |
| Pitch Attitude        | >=                      | -10       | None       |
| Yaw Rate              | >=                      | -5        | None       |
| Yaw Rate              | <=                      | 5         | None       |
| VH Fraction           | >                       | 0.7       | 0.01       |
| VH Fraction           | <=                      | 0.8       | 0.01       |
| Corrected Load Factor | >=                      | 0.85      | None       |
| Corrected Load Factor | <=                      | 1.18      | None       |
| Calibrated Airspeed   | >                       | 38        | 5          |
| Control Reversal Flag | =                       | 0         | None       |

FIGURE 23

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Filed: February 13, 2004

Agent: Anne E. Saturnelli

BFM-02501

Reg. No.: 41,290

Sheet 23 of 33

## Regime 7 - Level Flight, $0.9 V_H$

Description: Straight and level flight at close to 1.0 G conditions, airspeed from  $0.8 V_H$  to  $0.9 V_H$ .

| Maneuver Name         | Level Flight, $0.9 V_H$ |           |            |
|-----------------------|-------------------------|-----------|------------|
| Category              | Steady State            |           |            |
| Type                  | Specific                |           |            |
| Parameter             | Operator                | Threshold | Hysteresis |
| Landing Flag          | =                       | False     | None       |
| Takeoff Flag          | =                       | False     | None       |
| WOW                   | =                       | False     | None       |
| Roll Attitude         | >=                      | -10       | None       |
| Roll Attitude         | <=                      | 10        | None       |
| Rate of Climb         | >=                      | -500      | None       |
| Rate of Climb         | <=                      | 500       | None       |
| Sideslip              | <=                      | .05       | None       |
| Sideslip              | >=                      | -.05      | None       |
| Pitch Attitude        | <=                      | 10        | None       |
| Pitch Attitude        | >=                      | -10       | None       |
| Yaw Rate              | >=                      | -5        | None       |
| Yaw Rate              | <=                      | 5         | None       |
| VH Fraction           | >                       | 0.8       | 0.01       |
| VH Fraction           | <=                      | 0.9       | 0.01       |
| Corrected Load Factor | >=                      | 0.85      | None       |
| Corrected Load Factor | <=                      | 1.18      | None       |
| Calibrated Airspeed   | >                       | 38        | 5          |
| Control Reversal Flag | =                       | 0         | None       |

FIGURE 24

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BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 24 of 33



**Regime 8 - Level Flight, 1.0 V<sub>H</sub>**Description: Straight flight at close to 1.0 G conditions, airspeed from 0.9 V<sub>H</sub> to 1.0 V<sub>H</sub>.

| Maneuver Name         | Level Flight, 1.0 V <sub>H</sub> |           |            |
|-----------------------|----------------------------------|-----------|------------|
| Category              | Steady State                     |           |            |
| Type                  | Specific                         |           |            |
| Parameter             | Operator                         | Threshold | Hysteresis |
| Landing Flag          | =                                | False     | None       |
| Takeoff Flag          | =                                | False     | None       |
| WOW                   | =                                | False     | None       |
| Roll Attitude         | >=                               | -10       | None       |
| Roll Attitude         | <=                               | 10        | None       |
| Rate of Climb         | >=                               | -500      | None       |
| Rate of Climb         | <=                               | 500       | None       |
| Sideslip              | <=                               | .05       | None       |
| Sideslip              | >=                               | -.05      | None       |
| Pitch Attitude        | <=                               | 10        | None       |
| Pitch Attitude        | >=                               | -10       | None       |
| Yaw Rate              | >=                               | -5        | None       |
| Yaw Rate              | <=                               | 5         | None       |
| VH Fraction           | >                                | 0.9       | 0.01       |
| VH Fraction           | <=                               | 1.0       | 0.01       |
| Corrected Load Factor | >=                               | 0.85      | None       |
| Corrected Load Factor | <=                               | 1.18      | None       |
| Calibrated Airspeed   | >                                | 38        | 5          |
| Control Reversal Flag | =                                | 0         | None       |

FIGURE 25

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Filed: February 13, 2004

BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 25 of 33

## Regime 9 - Level Flight, 1.15 $V_H$

Description: Straight flight, and in a slight dive, at close to 1.0 G conditions, airspeed from 1.0  $V_H$  to 1.15  $V_H$ .

| Maneuver Name         | Level Flight, 1.15 $V_H$ |           |            |
|-----------------------|--------------------------|-----------|------------|
| Category              | Steady State             |           |            |
| Type                  | Specific                 |           |            |
| Parameter             | Operator                 | Threshold | Hysteresis |
| Landing Flag          | =                        | False     | None       |
| Takeoff Flag          | =                        | False     | None       |
| WOW                   | =                        | False     | None       |
| Roll Attitude         | >=                       | -10       | None       |
| Roll Attitude         | <=                       | 10        | None       |
| Rate of Climb         | >=                       | -500      | None       |
| Rate of Climb         | <=                       | 500       | None       |
| Sideslip              | <=                       | .05       | None       |
| Sideslip              | >=                       | -.05      | None       |
| Yaw Rate              | >=                       | -5        | None       |
| Yaw Rate              | <=                       | 5         | None       |
| VH Fraction           | >                        | 1.0       | 0.01       |
| VH Fraction           | <=                       | 1.15      | 0.01       |
| Corrected Load Factor | >=                       | 0.85      | None       |
| Corrected Load Factor | <=                       | 1.18      | None       |
| Calibrated Airspeed   | >                        | 38        | 5          |
| Control Reversal Flag | =                        | 0         | None       |

FIGURE 26

## Regime 10 - Level Flight, $> 1.15 V_H$

Description: Straight flight, and in a slight dive, at close to 1.0 G conditions, airspeed greater than  $1.15 V_H$ .

| Maneuver Name         | Level Flight, $> 1.15 V_H$ |           |            |  |
|-----------------------|----------------------------|-----------|------------|--|
| Category              | Steady State               |           |            |  |
| Type                  | Specific                   |           |            |  |
| Parameter             | Operator                   | Threshold | Hysteresis |  |
| Landing Flag          | =                          | False     | None       |  |
| Takeoff Flag          | =                          | False     | None       |  |
| WOW                   | =                          | False     | None       |  |
| Roll Attitude         | $>=$                       | -10       | None       |  |
| Roll Attitude         | $<=$                       | 10        | None       |  |
| Rate of Climb         | $>=$                       | -500      | None       |  |
| Rate of Climb         | $<=$                       | 500       | None       |  |
| Sideslip              | $<=$                       | .05       | None       |  |
| Sideslip              | $>=$                       | -.05      | None       |  |
| Yaw Rate              | $>=$                       | -5        | None       |  |
| Yaw Rate              | $<=$                       | 5         | None       |  |
| VH Fraction           | $>$                        | 1.15      | 0.01       |  |
| Corrected Load Factor | $>=$                       | 0.85      | None       |  |
| Corrected Load Factor | $<=$                       | 1.18      | None       |  |
| Calibrated Airspeed   | $>$                        | 38        | 5          |  |
| Control Reversal Flag | =                          | 0         | None       |  |

FIGURE 27

## TITLE: METHOD OF INFERRING ROTORCRAFT GROSS WEIGHT

Inventors: Timothy D. Flynn, et al.

Filed: February 13, 2004

BFM-02501

Agent: Anne E. Saturnelli

Reg. No.: 41,290

Sheet 27 of 33

**Regime 133 – 137 Level Left Turn**

Description: Left turn while in level flight

|                       |                 |           |            |
|-----------------------|-----------------|-----------|------------|
| Maneuver Name         | Level Left Turn |           |            |
| Category              | Transient       |           |            |
| Type                  | Generic         |           |            |
| Number of Sub Regimes | 5               |           |            |
| Parameter             | Operator        | Threshold | Hysteresis |
| Landing Flag          | =               | False     | None       |
| Takeoff Flag          | =               | False     | None       |
| WOW                   | =               | False     | None       |
| Roll Attitude         | <               | -10       | 3          |
| Rate of Climb         | >=              | -500      | None       |
| Rate of Climb         | <=              | 500       | None       |
| Corrected Load Factor | <=              | 1.18      | None       |
| Calibrated Airspeed   | >               | 38        | 2          |

1102

Sub-regime definitions: Level left turn

| Regime No. | Description                             | Prorate<br>1<br>AOB |
|------------|---|---------------------|
| 133        | 20° AOB Level Left Turn, 10° to 20° AOB | 2                   |
| 134        | 30° AOB Level Left Turn, 20° to 35° AOB | 3                   |
| 135        | 45° AOB Level Left Turn, 35° to 50° AOB | 4                   |
| 136        | 60° AOB Level Left Turn, 50° to 65° AOB | 5                   |
| 137        | > 60° AOB Level Left Turn, > 65° AOB    | 6                   |

1104

FIGURE 28

## Regime 138 - 142 Level Right Turn

Description: Right turn while in level flight

| Maneuver Name         | Level Right Turn |           |            |
|-----------------------|------------------|-----------|------------|
| Category              | Transient        |           |            |
| Type                  | Generic          |           |            |
| Number of Sub Regimes | 5                |           |            |
| Parameter             | Operator         | Threshold | Hysteresis |
| Landing Flag          | =                | False     | None       |
| Takeoff Flag          | =                | False     | None       |
| WOW                   | =                | False     | None       |
| Roll Attitude         | >                | 10        | 3          |
| Rate of Climb         | >=               | -500      | None       |
| Rate of Climb         | <=               | 500       | None       |
| Corrected Load Factor | <=               | 1.18      | None       |
| Calibrated Airspeed   | >                | 38        | 2          |

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BFM-02501

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Reg. No.: 41,290

Sheet 29 of 33

### Sub-regime definitions: Level Right turn

| Regime No. | Description                              | Prorate<br>1<br>AOB |
|------------|--|---------------------|
| 138        | 20° AOB Level Right Turn, 10° to 20° AOB | 2                   |
| 139        | 30° AOB Level Right Turn, 10° to 35° AOB | 3                   |
| 140        | 45° AOB Level Right Turn, 35° to 50° AOB | 4                   |
| 141        | 60° AOB Level Right Turn, 50° to 65° AOB | 5                   |
| 142        | > 60° AOB Level Right Turn, > 65° AOB    | 6                   |

FIGURE 29

**TITLE: METHOD OF INFERRING ROTORCRAFT GROSS WEIGHT**

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Reg. No.: 41,290

Sheet 30 of 33

1200

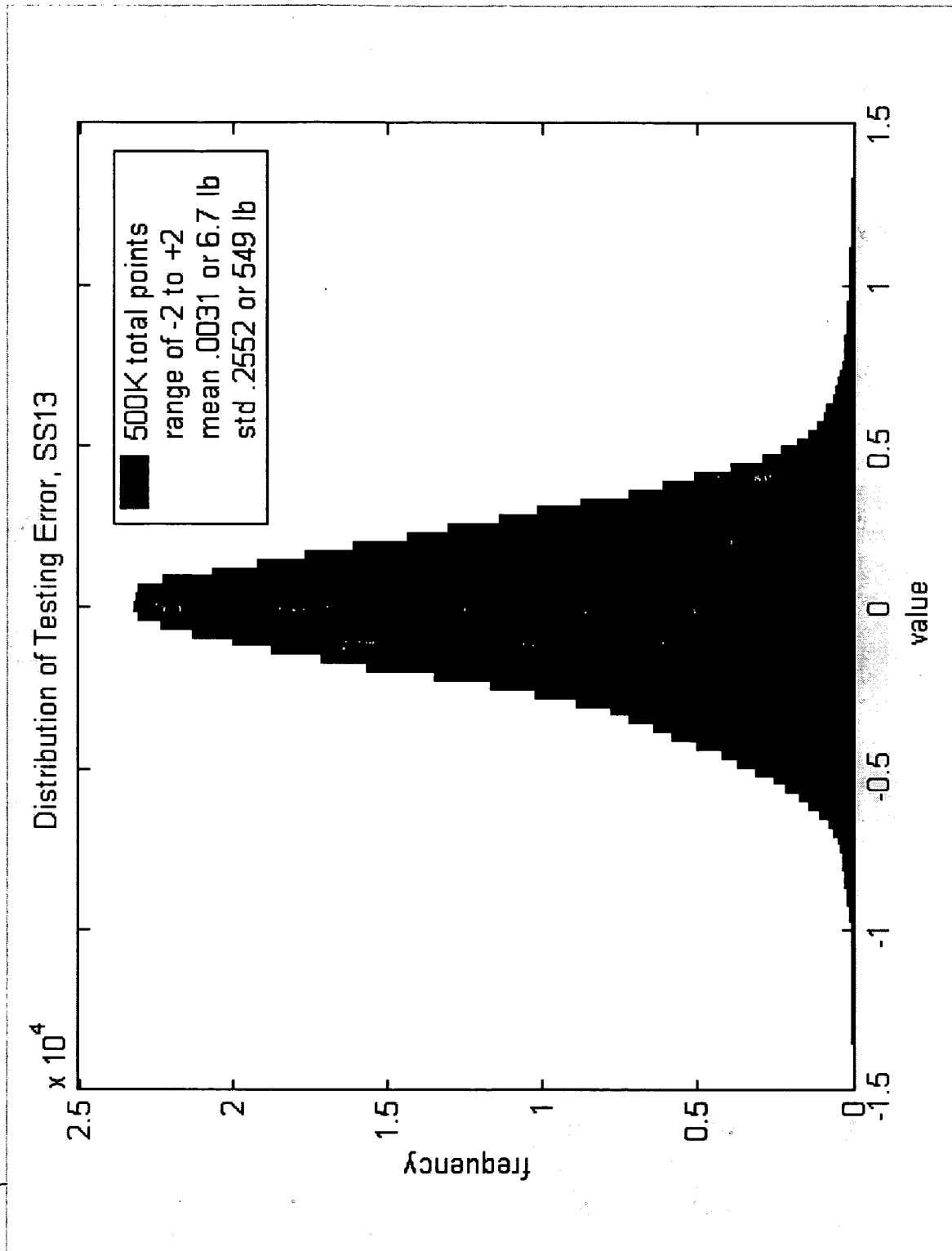


FIGURE 30

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Reg. No.: 41,290

Sheet 31 of 33

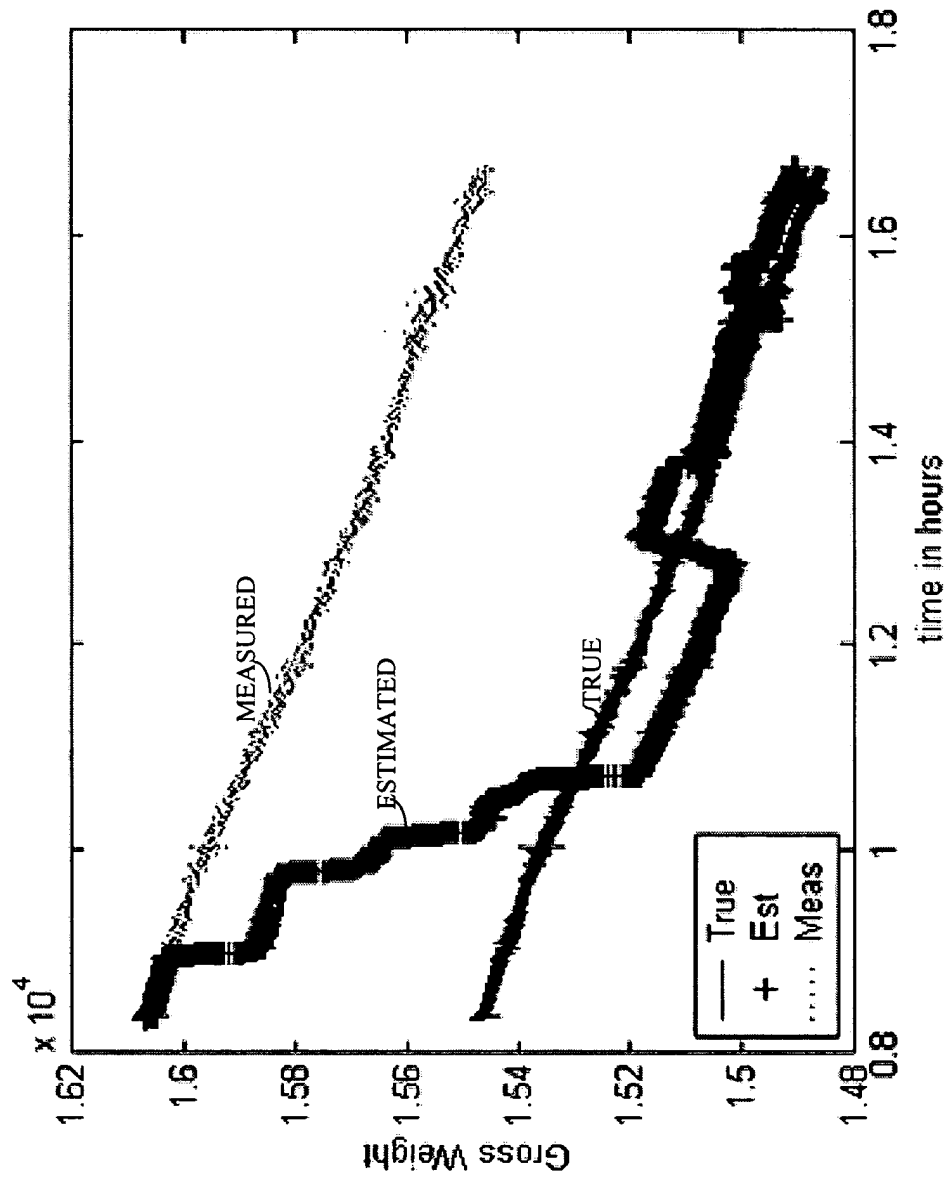


FIGURE 31

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Reg. No.: 41,290

Sheet 32 of 33

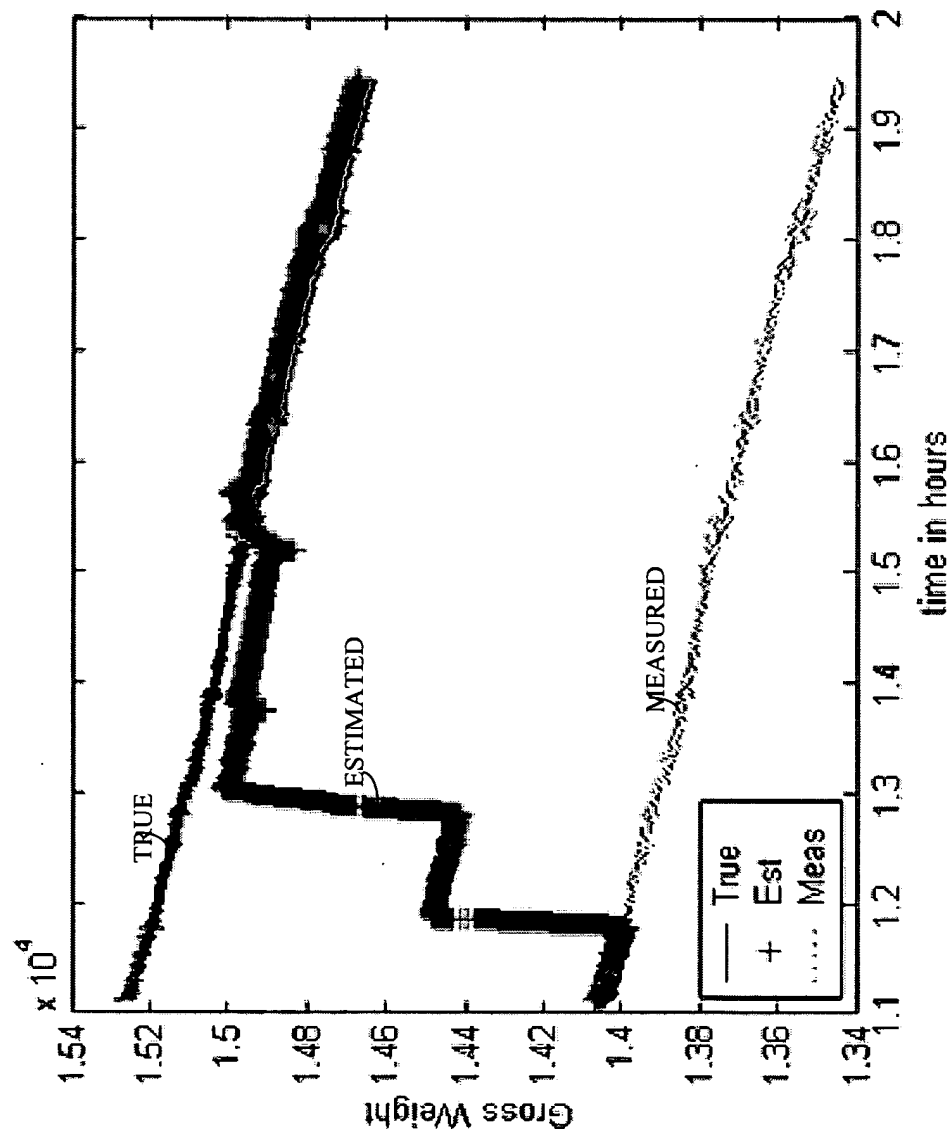


FIGURE 32



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Sheet 33 of 33

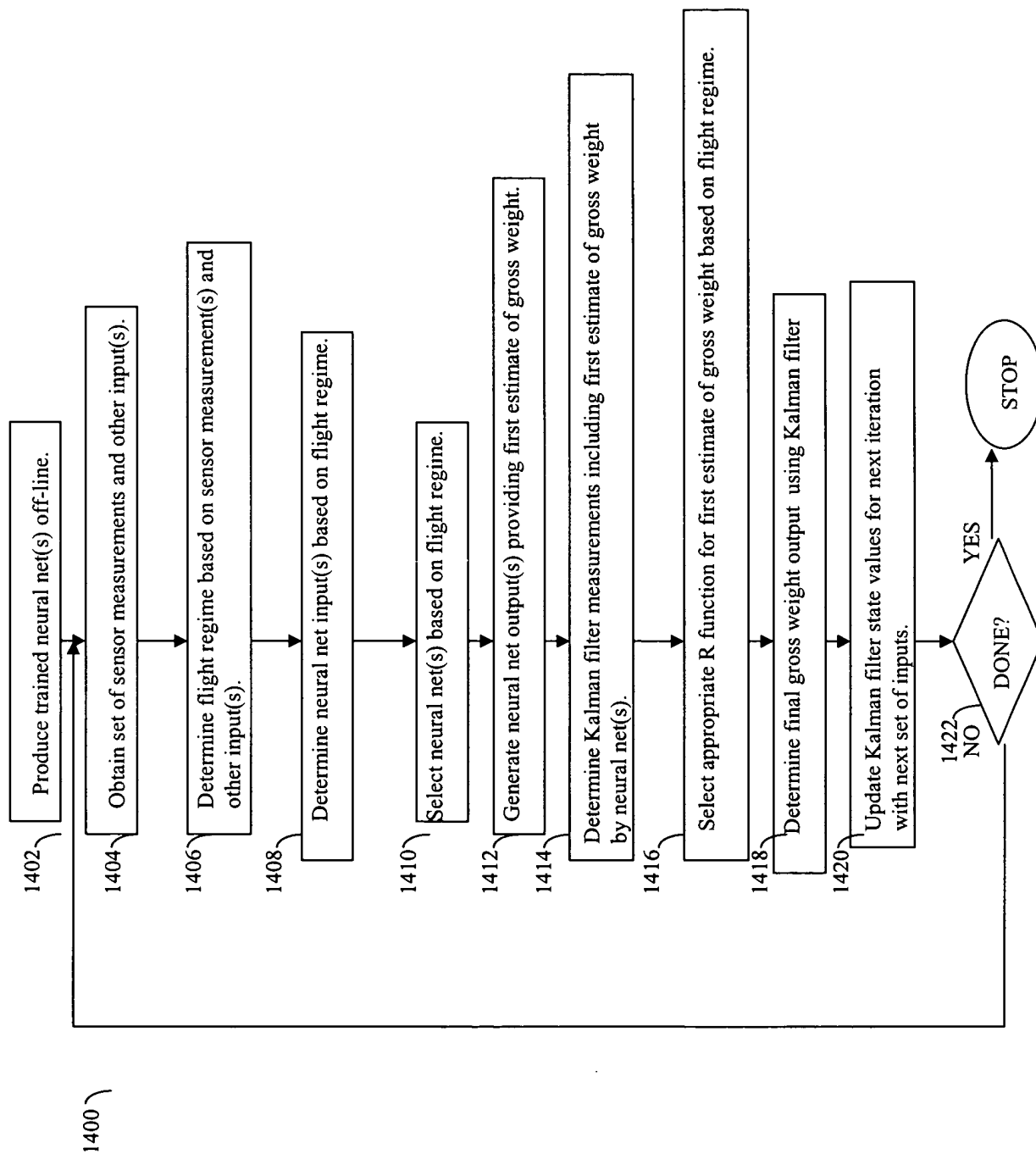


FIGURE 33